

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedure for Purging and Sampling Monitoring Wells

Version 1.0

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*Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.*

*Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.*

*Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.*



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Appendix A – Example field forms

## Environmental Assessment Program

Standard operating procedure for purging and sampling monitoring wells.

### **1.0 Purpose and Scope**

- 1.1 The Environmental Assessment Program (EAP) is responsible for measuring, assessing, and reporting information about the environmental condition and health of Washington's land and water resources. This information is used by resource managers, policymakers, and others to help protect and manage Washington's environment. As such there is a need to document and ensure that consistent and scientifically defensible practices, procedures, and techniques are used by EAP staff, and that the data and information they provide are of consistent and high quality.
- 1.2 The goals of collecting groundwater samples from monitoring wells are varied, but can include characterizing ambient conditions, defining the nature and extent of groundwater problems; or determining trends in contaminant concentrations with time, location, or both.
- 1.3 Groundwater measurements and samples should be as representative of in situ conditions as possible. Several factors such as changes in temperature, pressure, and exposure to air can alter the groundwater chemistry during the sampling process. This SOP summarizes the general procedures and practices that EAP staff use to collect representative groundwater samples from monitoring wells, piezometers, or other wells (e.g. irrigation wells) that do not have dedicated or in-place pumps.

### **2.0 Applicability**

- 2.1 This SOP applies to EAP staff collecting and handling groundwater samples from monitoring wells or other wells that do not have a dedicated down-hole pump. It provides general information to help guide field staff in proper purging and sampling techniques. Field staff are encouraged to supplement the information in this SOP by reviewing the large body of existing literature on the science of groundwater sampling (see reference list). Alternative procedures are allowed as long as they are properly documented in the project Quality Assurance Project Plan (QAPP), and provide scientifically valid and legally defensible groundwater data.
- 2.2 Field staff should be familiar with other standard procedures related to activities described in this SOP. Depending on the analyte being sampled for, there can be special sample pre-treatment, filtering, post-treatment, and collection procedures that are described in separate SOPs. Digital versions of all EAP SOP's can be found on Ecology's quality assurance page at <http://www.ecy.wa.gov/programs/eap/quality.html>.

### **3.0 Definitions**

- 3.1 Aquifer – A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield usable quantities of water to wells and springs.
- 3.2 Dissolved Oxygen – The relative amount of oxygen that is dissolved or carried in a given medium.
- 3.3 Data Quality Objectives (DQO's) – Data Quality Objectives are qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).
- 3.4 Depth-to-Water - also referred to in this SOP as water level measurement.
- 3.5 EAP – Environmental Assessment Program
- 3.6 Ecology – Washington State Department of Ecology
- 3.7 EIM – Environmental Information Management System. A searchable database developed and maintained by the Washington State Department of Ecology.
- 3.8 Field Data Sheets – Weather resistant sheets (“Rite in the Rain” ® writing paper) used to document all field activities, sample data, methods, and observations for each collection site.
- 3.9 GPS - Global Positioning System
- 3.10 Measuring Point – Established point on a well casing from which depth-to-water/water level measurements are collected to ensure data comparability.
- 3.11 ORP – Oxidation-Reduction Potential. The electric potential required to transfer electrons from one compound or element (the oxidant) to another compound (the reductant). Used as a qualitative measure of the state of oxidation in water.
- 3.12 pH – A measure of the acidity or alkalinity of water. A pH value of 0 to 7 indicates that an acidic condition is present, while a pH value of 7 to 14 indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.
- 3.13 Specific Conductance (SC) – A measure of the water's ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.

- 3.14 Quality assurance project plan (QAPP) – A written plan that describes how a study will be conducted and its results assessed.

#### **4.0 Personnel Qualifications/Responsibilities**

- 4.1 Staff new to groundwater sampling should review the most recent USGS National Field Manual for the Collection of Water-Quality Data (USGS, 1997); The Essential Handbook of Ground-Water Sampling (Nielsen, 2007), or an equivalent, for background information on the principles and techniques of groundwater monitoring. Staff should have a working understanding of the groundwater monitoring needs for their project prior to preparing the project Quality Assurance Project Plan (QAPP) and beginning field work.
- 4.2 Field staff should have a detailed working knowledge of the project QAPP to ensure that credible and useable data are collected and should be briefed by the field lead on the sampling goals and objectives prior to arriving at the site.
- 4.3 This document supplements but does not replace the need for on-the-job training. All field staff should be familiar with the sampling equipment and instruments being used. The field lead is responsible for ensuring that all field staff adhere to prescribed sampling methods when conducting field work.
- 4.4 EAP staff who conduct groundwater sampling are responsible for complying with this SOP and the requirements of the EAP safety manual - particularly Chapter 1 'General Field Work' and the following sections of Chapter 2: 'Groundwater Sampling and Water-Level Measurements' and 'Hazardous Waste Sites' (Ecology, 2009).

#### **5.0 General List of Equipment and Supplies**

- 5.1 Sample Measuring and Collecting Equipment
- 5.1.1 Field data sheets
- 5.1.2 Water level measuring equipment (calibrated electric water level meter, graduated steel tape)
- 5.1.3 Water quality meters and probes (pH, SC, DO, temperature, ORP)
- 5.1.4 Probe calibration standards/reagents
- 5.1.5 Flow cell
- 5.1.6 Pump (submersible, peristaltic, bladder)
- 5.1.7 Power supply (generator, battery)
- 5.1.8 Extension cord
- 5.1.9 Tubing and connectors
- 5.1.10 Sample containers/bottles
- 5.1.11 Sample preservatives
- 5.1.12 Filters (analyte specific)
- 5.1.13 Coolers with ice or ice packs
- 5.1.14 55-gallon barrels (to store and properly dispose of contaminated purge water)

- 5.2            Cleaning and Disinfecting Supplies
- 5.2.1        Deionized water
- 5.2.2        Laboratory grade soap (Liquinox®)
- 5.2.3        Dilute chlorine bleach solution
- 5.2.4        Cleaning solvents, if applicable
  
- 5.3            Safety Equipment
- 5.3.1        Nitrile gloves
- 5.3.2        Hearing protection
- 5.3.3        Safety goggles
- 5.3.4        Hard hat
- 5.3.5        First aid kit
- 5.3.6        Orange vest, Ecology issued
- 5.3.7        Traffic cones
- 5.3.8        Traffic signs, if applicable
  
- 5.4            Miscellaneous Equipment
- 5.4.1        Well location map
- 5.4.2        All applicable SOPs
- 5.4.3        Field paper work: property owner contact information, field data sheets, sample bottle labels and tags, chain-of-custody sheets.
- 5.4.4        Pencils, pens, etc.
- 5.4.5        Permanent marking pen or paint stick (for marking measuring point)
- 5.4.6        Calculator
- 5.4.7        Well keys, if applicable
- 5.4.8        Compass
- 5.4.9        GPS unit
- 5.4.10       Digital camera
- 5.4.11       Paper towels or clean rags
- 5.4.12       Plastic garbage bags
- 5.4.13       Plastic sheeting for ground cover
- 5.4.14       Buckets, plastic 5-gallon
- 5.4.15       1-liter container (to calibrate purge volume/rate)
- 5.4.16       Stop watch
- 5.4.17       Field bag (containing rain gear, rubber boots, work gloves, etc.)
- 5.4.18       Hand cleaner
- 5.4.19       Product/Water interface probe, if applicable
  
- 5.5            Tools
- 5.5.1        Steel hand measuring tape (engineer scale)
- 5.5.2        Socket wrench set
- 5.5.3        Allen wrench set
- 5.5.4        Pipe wrenches
- 5.5.5        Crescent wrenches
- 5.5.6        Set of screwdrivers
- 5.5.7        File

- 5.5.8 Knife
- 5.5.9 Hammer
- 5.5.10 Pliers
- 5.5.11 Hack saw
- 5.5.12 Crow bar/manhole hook
- 5.5.13 Shovel
- 5.5.14 Machete
- 5.5.15 Whiskbroom
- 5.5.16 Spare well cover bolts/nuts
- 5.5.17 Spare well caps/plugs
- 5.5.18 Spare pad locks/keys
- 5.5.19 Wire brush
- 5.5.20 WD-40 (to be used away from the well head)
- 5.5.21 Bailing device (e.g. cooking baster, peristaltic pump with battery)
- 5.5.22 Flashlight
- 5.5.23 Spare batteries (e.g. electric-tape, GPS, flashlight)
- 5.5.24 Tape (duct tape/electrical tape)
- 5.5.25 Well tagging equipment

## **6.0 Summary of Procedure**

### **6.1 Project Planning**

- 6.1.1 A Quality Assurance Project Plan (QAPP) must be completed and approved before collecting water quality samples for analysis. The QAPP details project goals, data quality objectives, quality assurance program procedures, sample handling requirements (container requirements, preservation, holding times), and field and laboratory procedures. [Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies](#) (Lombard, 2004) provides detailed guidance on developing EAP project plans. A QAPP can reference SOPs for standard field monitoring or measurement procedures; however, non-standard procedures or deviations should be described in detail in the QAPP.
- 6.1.2 Detailed information should be collected for each well location whenever practical, including well construction logs, water level data, site access agreements, and any other relevant information about the wells to be sampled. An example of a well reconnaissance field form is included in Appendix A.
- 6.1.3 Well location and construction information for wells that are sampled should be entered into Ecology's Environmental Information Management (EIM) system database.
  - 6.1.3.1 If the well hasn't been previously inventoried, use a GPS receiver when visiting the well to define a preliminary latitude and longitude coordinates as described in SOP EAP013, *Determining Coordinates via Hand-Held GPS Receivers* (Janisch, 2006). The field-collected coordinates can be refined using mapping tools when entering the well into the EIM system.

- 6.1.3.2 If the well hasn't been assigned a Department of Ecology unique well ID tag, then it should be tagged as described in EAP SOP *Tagging Wells* (in preparation). Well tags are available from Ecology's Water Resources Program. Securely attach the tag to the well casing, or any other permanent, easily-seen fixture of the well. Once a well is tagged, complete the well tag form and submit to Ecology's Water Resource Program along with a copy of the well log.
- 6.1.4 Selecting equipment for purging and sampling a well requires site- and project-specific considerations. Equipment, materials, and manner of operation must be compatible with characteristics of the well and the analytes being sampled to obtain data that will meet the project objectives and data quality requirements. General considerations for equipment selection are discussed in Section 6.2. More detailed information can be found in documents such as the USGS National Field Manual for the Collection of Water-Quality Data, and Nielsen (2007) *The Essential Handbook of Ground-Water Sampling*.
- 6.2 Sample Equipment Selection
- 6.2.1 Groundwater chemistry can be altered by changes in temperature, pressure, and exposure to air that are brought on by the sampling process. Therefore, it is imperative to select sample equipment and follow sampling procedures that minimizes these changes.
- 6.2.2 Factors to consider when selecting proper sample equipment include: analytes being evaluated, type and location of the well, physical characteristics of the well (diameter and total depth), depth to water, the amount of water to be purged, geology adjacent to the screened interval and the groundwater chemistry.
- 6.2.2.1 Sample equipment must be compatible with the analytes being sampled. This includes the materials the sample equipment is made of, as well as its proper operation.
- 6.2.2.2 Sampling equipment can be a source of sample bias or error. Equipment that contacts the sample should be made of inert material to the extent possible. Materials commonly used include high quality stainless steel (pumps), and various forms of plastic (pumps, pump tubing and connectors). As explained by Nielsen (2007), the materials should not sorb analytes from samples, desorb previously sorbed analytes into samples, leach matrix components that could affect analyte concentrations or cause artifacts, or be physically or chemically degraded by the water chemistry. In general, the softer or more flexible forms of any metal or plastic have been found to be more reactive than the rigid forms. An example of this is the pump tubing which has the potential to provide a source of error because of the amount of contact with the sampled water, both in surface area and time. There is a wide selection of tubing available for use, ranging from soft to rigid. Overall, soft tubing (e.g. silicone, polyvinyl chloride - Tygon®) is found to be more gas permeable and sorptive of organic compounds. It is suitable for sampling inorganic analytes only. The more rigid tubing (e.g.

polytetrafluorethylene (Teflon®), polyethylene, and propylene) appear to offer greater performance over other materials for both inorganic and organic analytes.

- 6.2.2.3 The physical characteristics of a well may also dictate equipment selection. Smaller diameter wells are becoming increasingly common in groundwater investigations. Such wells limit the potential range of equipment that can be used for sample collection (e.g. peristaltic pump, small diameter bladder pump or bailer).
- 6.2.2.4 The depth to water may also dictate equipment selection. All sample pumps have a defined lift capability. This is the ability of the equipment to move water from the static water level depth to the ground surface. For example the lift capability of suction-based pumps (peristaltic and centrifugal pumps) is about 25 feet. Depth to water also effects pump operation, since the pumping rate typically decreases with increased depth to water.
- 6.2.2.5 Being able to control the pumping rate is an important consideration when selecting sample equipment. Sampling rates should be high enough to fill sample containers efficiently and with minimal exposure to the atmosphere, but low enough to minimize sample alteration by agitation or aeration. This is especially important for sensitive analytes, such as volatile organic compounds and trace metals, which should be taken at low flow rates.

### 6.3 Field Work Preparation

- 6.3.1 Prior to sampling, inventory consumable field supplies such as disposable gloves, calibration standards, tubing, filters, etc. Order necessary supplies. Allow ample time for delivery.
- 6.3.2 Arrangements must be made with Ecology's Manchester Environmental Laboratory before sampling. The [Manchester Environmental Laboratory \(MEL\) Laboratory User's Manual](#) (Ecology, 2008) contains detailed guidance on the planning steps necessary to request, track, ship, and analyze water quality samples collected in the field.
  - 6.3.2.1 To notify the lab submit a [Pre-sampling Notification Form](#) and a [Sample Container Request Form](#) a minimum of 2 weeks prior to sampling. For large projects the lab should be informed 4-6 weeks prior to sampling.
  - 6.3.2.2 Coordinate with the lab regarding any special arrangements such as contract lab analysis, special courier or delivery of samples.
  - 6.3.2.3 Inventory sample bottles when they arrive to ensure the lab provided the correct type and number.
- 6.3.3 Establish the order the wells will be sampled. Sample order is either based on logistics or the known or suspected water quality of a sample location. For contaminated wells, the order of sampling should be from least potentially contaminated well to most potentially contaminated well. This minimizes the possibility for cross-contamination of the sample equipment.

- 6.3.3.1 Obtain permission for site access if needed. Contact the property owner, property operator or resident to confirm the sampling date and time and to discuss any site access issues.
- 6.3.3.2 Before going in the field prepare field data sheets for each well location. It can be helpful to bring previous sample data for each well such as water level, pump intake placement, pump rate, total purge time, stabilized field parameter values, etc. Other sample paperwork should also be filled out as much as possible. Sample paperwork typically includes: bottle labels and tags, as well as Manchester Labs Chain-of-Custody/[Lab Analysis Required Form](#) (LAR) for the project sample event. Examples of field data sheets are provided in Appendix A.
- 6.3.4 Inspect all equipment and verify that water quality field meters are in good working order, calibrate properly, and are fully charged. Calibration procedures are normally outlined in the meter user's manual.
- 6.3.5 Field equipment, especially equipment being placed in a well, that is going to be reused must be properly cleaned, disinfected, or decontaminated prior to and after use in each well. Cleaning procedure depends on the equipment being used (water level equipment, field parameter probes, down well sample equipment) and the type of well being sampled (e.g. observation well, piezometer, or regulated facility monitoring well).
  - 6.3.5.1 It is recommended that gloves (Nitrile) be worn when cleaning sample equipment. This will help maintain sanitary conditions of the cleaned equipment and will protect the sampler from the cleaning products being used. When not in use, equipment should be placed on a clean surface, such as a clean plastic sheet. If the equipment is not re-used immediately it should be wrapped in plastic sheeting or aluminum foil. Equipment should never be placed on bare soil prior to using it in a well.
  - 6.3.5.2 Water level measuring equipment: rinse the probe and any submerged tape with deionized water before and after use in a well. Wipe or air dry. If the well is suspected or known to be contaminated, the probe and any submerged tape should be wiped with a disinfectant-soaked towel or washed in a laboratory grade soap (e.g. Liquinox) solution, followed by a tap water and deionized water rinse.
  - 6.3.5.3 Water quality field probes may be rinsed with deionized water between sample locations. If the probes are slow to respond and additional cleaning is needed, then the probes should be cleaned and maintained according to the manufacturer's instructions.
  - 6.3.5.4 Down well equipment, such as a submersible pump, should be washed in a laboratory grade soap (e.g. Liquinox) solution. Use a brush to scrub the exterior of the sample equipment. Rinse the equipment with tap water, followed by a deionized water rinse. Parts of the sample equipment that are difficult to submerge while cleaning, like a pumps electrical cable, can be wiped down with a disinfectant-soaked towel.

- 6.3.5.5 If the equipment is used in a contaminated well, additional cleaning may be required. The equipment may need a chemical rinse (e.g. acetone, nitric acid, methanol, isopropyl alcohol) depending on what analytes are being sampled. Rinse the equipment with deionized water. Place the equipment on a clean surface to air dry.
- 6.3.5.6 Equipment that is difficult to clean, such as pump tubing, should be replaced between sample locations. As mentioned previously pump tubing has the potential to provide a source of error because of the amount of contact with the sampled water. Therefore to help prevent possible cross-contamination it is advisable not to reuse sample tubing between sample locations. For long-term projects tubing may be dedicated to a well, but should not be used at other locations.

#### 6.4. Purging and Sampling Procedures

- 6.4.1 All groundwater sampling follows the same basic standard procedures. These generally include checking and setting up the field sample equipment, collecting an initial water level measurement, installing sample equipment in the well, purging the well at a low flow rate, properly collecting, preserving and labeling all samples, and safely delivering the samples to the lab. Each step should be followed with care to ensure that collected groundwater samples meet-the objectives and data quality requirements of the project.
- 6.4.2 Upon arriving at a well, set out safety equipment such as traffic cones and signs as needed.
- 6.4.3 Check the site for hazardous conditions, either physical or chemical.
- 6.4.4 If needed, spread clean plastic sheeting on the ground around the well to keep sample equipment clean.
- 6.4.5 Set up and field check sample equipment: water level meter, water quality meters and flow cell, selected pump and power supply, etc.
- 6.4.5.1 Wear clean disposable powder-free gloves (e.g. Nitrile) when handling all equipment used for collecting and processing samples.
- 6.4.5.2 Calibrate field water quality meters according to the manufacturer's instruction. Field parameters should be measured in a closed-atmosphere flow cell. If for some reason it's not possible to use a flow cell at a particular location, it should be noted on the field data sheet.
- 6.4.5.3 If a gasoline-powered generator is used for the pump power supply, locate it as far from the well head or sample collection area as possible, preferably downwind.
- 6.4.6 Remove the well cover and cap. For monitoring wells on regulated facilities you will probably need a key.

- 6.4.6.1 If the well has not been sampled before, establish and document a water level measuring point using the procedures described in SOP EAP052, *Manual Well Depth and Depth-to-Water Measurements* (Marti 2009).
- 6.4.6.2 If the well is equipped with a pressure transducer or other down well instrumentation carefully note its position. Remove the instrumentation from the well according to SOP EAP074, *Use of Submersible Pressure Transducers during Groundwater Studies* (Sinclair and Pitz 2010). Note the removal time on the field data sheet.
- 6.4.7 Measure the static water level according to SOP EAP052 (Marti, 2009). Record the water level value, date, and time on the well specific field data sheet (Appendix A). The water level should be measured twice to confirm an accurate measurement. The water level should be measured before inserting any other field equipment into the well.
- 6.4.8 It can be helpful to know the amount of standing water in a well, particularly for projects where the purge water needs to be managed. To calculate the amount of standing water in one well volume, use the following information: measured water level, well diameter and total depth. The amount of standing water can be calculated using a variety of methods. One equation is:
- Well volume =  $V = 0.041 \times HD^2 = \text{___} \text{ gallons}$ , where
- $V$  is volume of water in the well, in gallons,  
 $H$  is height of water column (total depth – measured water level =  $H$ ), in feet, and  
 $D$  is inside well casing diameter, in inches
- 6.4.9 If the well is not equipped with a dedicated sampling system, install a decontaminated pump (e.g. submersible, bladder) or pump tubing (e.g. peristaltic). Slowly lower the equipment through the water column to avoid stirring up particulates. Place the intake at its final depth before starting to purge. The final intake position should be set at the point of sample collection.
- 6.4.9.1 If the well has been sampled before, the final pump intake should be placed at the same depth as used in previous sample events. Record the intake depth on the field data sheets.
- 6.4.9.2 If the well has not been sampled before position the pump intake at a depth prescribed by the project manager/field lead. Position of the pump intake is typically near or within the screened or open interval of the well. The final intake depth depends on the project objectives and should be specified in the QAPP.
- 6.4.10 Once the pump or pump tubing has been placed in the well, slowly lower the water level probe back into the well to measure water levels throughout purging. This is particularly important for low yield wells.

- 6.4.11 If the well has been sampled before, review past field data sheets for purge rates, total purge time, stabilized field parameter values, and amount of drawdown if any, prior to sample collection.
- 6.4.12 Start purging. Set the pump controller to the desired pumping rate (e.g. 1 L/min or less). Use a 1 L bottle and stopwatch to measure the pump rate.
- 6.4.12.1 Ideally, wells should be purged and sampled at flow rates at or less than the natural flow conditions of the aquifer in the screened interval to avoid drawing the well water level down. Use measured water levels to help determine the pump rate, which should not exceed 1L/min. Record the pump rate on the field data sheet.
- 6.4.12.2 Purging should not cause a significant drawdown in the well. Significant drawdown is considered to be 5 percent of the total height of the water column or depth to the top of the screen. If an unacceptable drawdown does occur, gradually decrease the pump rate until the water level stabilizes to an acceptable level. Record the new pump rate on the field data sheet.
- 6.4.12.3 Do not use an attached valve to reduce the pump flow. Reducing the flow rate with a valve can cause sample agitation and alteration
- 6.4.13 Purge water from wells that are not on regulated facilities or related to site cleanup work may be discharged directly to the ground as long as the water is not contaminated. Direct the purge water away from the wellhead and work area. Purge water from wells associated with a regulated facility or cleanup site that is contaminated should be disposed of in accordance with Washington State regulations (Chapter 173-303-400 WAC).
- 6.4.14 During purging and sample collection the flow should be a smooth, solid stream of water with no air or gas bubbles in the tubing or flow cell. Gradually adjust the pumping rate to eliminate bubbles if present.
- 6.4.15 Once the flow is constant begin monitoring field parameter values in a flow cell at regular intervals (e.g. 2 to 5 minutes). The frequency of these measurements depends on the pump rate and the estimated time for the field parameters to stabilize. At a minimum, there should be a complete exchange of water in the flow cell between measurements.
- 6.4.16 Record the field parameter values, time of measurement, water level, and if tracking, the amount of purge water discharged. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems. Record observations on the pumped water's appearance (e.g. clarity, odor, etc.) during purging and sampling.

- 6.4.17 Continue purging until field parameters stabilize. At a minimum, five sets of field measurements should be recorded. Monitored field parameters for EAP studies include but are not limited to pH, specific conductance, dissolved oxygen, and water temperature. Field parameters should be specified in the project QAPP.
- 6.4.18 Field parameters are considered stable when 3 consecutive readings fall within the following stabilization criteria:
- |                      |  |
|----------------------|--|
| pH                   | ± 0.1 standard units   |
| Specific Conductance | ± 10.0 µmhos/cm for values < 1000 µmhos/cm<br>± 20.0 µmhos/cm for values > 1000 µmhos/cm |
| Dissolved Oxygen     | ± 0.05 mg/L for values < 1 mg/L<br>± 0.2 mg/L for values > 1 mg/L                        |
| Temperature          | ± 0.1° Celsius   |
| ORP                  | ± 10 millivolts  |
- 6.4.18.1 If sampling for metals, turbidity should be measured and have either stabilized or be below 10 NTUs. Turbidity readings should be below 5 NTUs if metals samples will not be filtered.
- 6.4.19 Once field parameters stabilize conduct any end of purge field parameter analysis (e.g. low dissolved oxygen, alkalinity, iron) as specified in the project QAPP.
- 6.4.20 Collect samples once field parameters stabilize and any other field data has been collected. Do not stop or significantly change the pumping rate during the final phase of purging or while sampling. Purging and sample withdrawal should form a continuous process.
- 6.4.21 Samples should be collected in a specific order as determined in the project QAPP. The order of sample collection, processing and preservation for specific analytes should be adhered to consistently throughout a project. The recommended sequence for sample collection and processing is often based on logistics for maintaining sample integrity.
- 6.4.21.1 Sample collection order is usually based on the analytes' sensitivity to change. Those analytes most sensitive to change (e.g. organics) are usually collected first, while analytes less sensitive to change (e.g. nutrients) may be collected last.
- 6.4.21.2 The sequence can be modified, depending on the types of samples to be collected and on data objectives. The relative importance of each analyte should be evaluated by project. Samples for analytes of most interest may be collected first to ensure that a representative sample is obtained. This is particularly important when sampling low-yielding wells which may not have a sufficient volume of water to fill all sample containers.

- 6.4.21.3 Modification in sample order may also be necessary to maintain sample integrity. For example, sulfate samples should be collected before samples preserved with sulfuric acid (e.g. nitrogen series, phenolics). This can prevent the accidental contamination of an unpreserved sulfate sample with sulfuric acid preservative used for another sample. Likewise, nitrogen series samples should be collected before samples preserved with nitric acid (e.g. total and dissolved metals).
- 6.4.21.4 When filtering samples for several analytical parameters they should be filtered in a specific order so that the analytical concentration will not be significantly affected as the pore size of the filter decreases as more water passes through it. For example the USGS (Wilde, 2004) recommends the following filter sequence: trace elements, mercury, major cations, major anions and nutrients (including alkalinity), radiochemicals, and stable isotopes.
- 6.4.22 Change to clean disposable powder free gloves, if needed.
- 6.4.23 Prepare sample containers. To avoid possible container contamination, keep sample containers capped until it's time to fill them.
- 6.4.24 Sample containers are to be filled by transferring water directly from the sampling apparatus (discharge tubing, filters, etc.) into the appropriate sample container. During sample collection the discharge line/filter should be close to but not touching the sample container.
- 6.4.24.1 Follow industry standard procedures for sample collection and preservation, for example procedures discussed in the USGS National Field Manual for the Collection of Water-Quality Data (USGS, 1997). The EA Program is in the process of preparing analytes specific SOPs for sample collection and preservation for volatile organic compounds, metals, and general/physical chemistry parameters.
- 6.4.24.2 All samples requiring preservation must be preserved as soon as practical. Refer to analyte specific SOPs for proper preservations methods.
- 6.4.24.3 Collect quality control (QC) samples such as a field replicate from the well(s) specified in the project QAPP. Field replicate samples are collected by alternating the sample stream between two of the same type sample container.
- 6.4.25 Label sample containers and immediately place in an ice filled cooler. Samples must remain at or below 6°C throughout handling, storage, and shipping. Do not freeze samples.
- 6.4.26 Record sample date and time, final water level, and total purge volume on the field data sheet. Record any final observations or comments related to sample collection.

- 6.4.27 Follow the procedures in the project QAPP or Manchester Lab Manual for sample handling and management (e.g. chain of custody, sample courier service or any special shipping requirements or restrictions).
- 6.4.27.1 Be conscious of analytical holding times and minimize the time between sampling and delivery to the laboratory.
- 6.4.28 If the well was equipped with a transducer or other down well instrumentation, replace the equipment according to SOP EAP074, *Use of Submersible Pressure Transducers during Groundwater Studies* (Sinclair and Pitz 2010). Note the reinstall time on the field data sheet,
- 6.4.29 When all work at the well site is complete, properly close and secure the well.
- 6.4.30 Note any physical changes to the well on the field data sheets, such as erosion or cracks in the protective concrete pad or alteration to the well casing.
- 6.4.31 All equipment used to collect groundwater samples should be cleaned or disinfected as previously described. Store the equipment for transport to the next sample location or at the conclusion of the field study.
- 6.4.32 Before leaving the site make certain that all the appropriate quality control samples have been collected. These may include a field replicate, and field blanks (e.g. filter, equipment, transport). The types and number of quality control samples should be specified in the project QAPP.
- 6.5 Low Volume and Poor Recovery Wells - Purging and Sampling Procedures
- 6.5.1 In some situations, even with a low pumping rate, some wells may experience a significant drawdown or may even purge dry. Slow recovering wells or wells that purge dry require extra care in order to be purged and sampled with minimal disturbance to the water column and fine materials in and around the well screen.
- 6.5.2 For low volume and poor recovery wells, review past field data sheets if available for previous purge rates, amounts of drawdown, and purge volume prior to sample collection.
- 6.5.3 Measure the well's water level as described in steps 6.4.6. and 6.4.7.
- 6.5.4 If you suspect the well may be low yielding, calculate the amount of standing water in one well volume as described in step 6.4.8.
- 6.5.5 If the well is not equipped with a dedicated sampling system, install a decontaminated pump or pump tubing. Slowly lower the equipment through the water column to avoid stirring up particulates. The final pump intake depth should be near the bottom of the screened interval. To prevent stirring up particulates it is important not to touch the well bottom. Record the intake depth on the field data sheets.

- 6.5.6 Once the pump or pump tubing is in place, slowly lower the water level probe back into the well. It is important to continually measure the water level throughout purging in low volume or poor recovery wells.
- 6.5.7 Start purging at a rate less than 0.5 liter per minute if the pump capacity allows. Record the pump rate on the field data sheet.
- 6.5.8 At regular intervals record field parameter values, water level, time of measurement, and amount of purge water discharged. Allow a complete exchange of water in the flow cell between measurements. Note and provide qualifying remarks if parameter readings are anomalous, the water level is dropping or if at some point the water level stabilizes. Record observations on the pumped waters appearance (e.g. clarity, odor, etc.) during purging and sampling.
- 6.5.9 Continue purging until field parameters stabilize. Attempts should be made to avoid purging slow recovery wells dry. However, if this is not possible shut the pump off and allow the well to recover at least once before collecting samples. This generally constitutes an adequate purge, and the well can be sampled as soon as an adequate volume of water has recovered to fill the sample containers. If time permits, purge the well a second time. Samples should be collected within 24 hours of recovery.
- 6.5.9.1 It should be noted that there can be significant alterations in the groundwater chemistry when a well is purged dry and allowed to recover. Groundwater chemistry can change as formation water surrounding or entering the screened interval of the well is exposed to air which can affect volatile organics and redox sensitive analytes. Increased turbidity can also be an issue when sampling metals and some general chemistry parameters (Nielsen, 2007).
- 6.5.10 Collect samples once field parameters stabilize and any end of purge analysis has been conducted.
- 6.5.10.1 If the well has been purged dry and allowed to recover, field parameters should be measured at the time of sampling if there is an adequate volume of water.
- 6.5.11 Sample containers should be filled in the order specified in the project QAPP. However, when sampling low-yielding wells which may not have a sufficient volume of water to fill all the sample containers, the relative importance of each analyte should be evaluated. Samples for analytes of most interest should be collected first to ensure that a representative sample is obtained. Discuss with the lab the minimum volume of sample needed for each analyte.
- 6.5.12 Fill, preserve, label and store sample containers as described in steps 6.4.24 through 6.4.27.
- 6.5.13 Record sample date and time, final water level, and total purge volume on the field data sheet. Record any final observations or comments related to sample collection such as elapsed time for complete purge of the well and recovery rate of the well.

- 6.5.14 Follow the procedures in the project QAPP or Manchester Lab Manual for sample handling and management (e.g. chain of custody, sample courier service or any special shipping requirements or restrictions). Be conscious of analytical holding times and minimize the time between sampling and delivery to the laboratory.
- 6.5.15 Replace any down well instrumentation according to EAP074, *Use of Submersible Pressure Transducers during Groundwater Studies* (Sinclair and Pitz 2010). Note the reinstall time on the field data sheet.
- 6.5.16 Properly close and secure the well.
- 6.5.17 Note any physical changes to the well on the field data sheets, such as erosion or cracks in the protective concrete pad or alteration to the well casing.
- 6.5.18 All equipment used to collect groundwater samples should be cleaned or disinfected as previously described. Store the equipment for transport to the next sample location or at the conclusion of the field study

## **7.0 Records Management**

- 7.1 Monitoring wells that EAP samples must be documented to enable information about their location, construction, and subsequent monitoring data to be archived in Ecology's Environmental Information Management (EIM) system and well log imaging databases. Consult the EIM help documents for a list of the well specific metadata required by EIM.
- 7.2 Station information and monitoring notes should be documented, during each site visit on site specific field data sheets. Examples are presented in Appendix A. All field entries should be neat and concise. The field lead is responsible for reviewing the form(s) for completeness before leaving a field site.
- 7.3 EAP staff have developed a number of data analysis spreadsheets, field forms, and other tools to standardize data collection and processing for groundwater monitoring projects. See the EAP Groundwater Assessment Sharepoint site for the most up-to-date version of these tools. Examples of some of the field forms are provided in Appendix A.
- 7.4 All hardcopy documentation, such as well reports and field data sheets, are kept and maintained by the project lead. At the completion of a project, hardcopies are boxed and moved to EAP archives.

## **8.0 Quality Control and Quality Assurance**

- 8.1 To ensure that good quality data are obtained throughout a project, a Quality Assurance Project Plan (QAPP) must be completed and approved before performing any field work. The QAPP details project goals, data quality objectives, quality assurance program procedures, sample handling requirements, and field and laboratory procedures.

- 8.2 Both the equipment and procedures used in collecting and handling groundwater samples have limitations that introduce a certain level of error, variability and bias into the final analytical results. To minimize the level of error, all field staff should follow these general QA/QC procedures when collecting samples:
- 8.2.1 Follow the project QAPP and any applicable standard operating procedures (SOP) when collecting and handling samples.
- 8.2.2 Calibrate field water quality meters according to the manufacturer instructions.
- 8.2.3 Use equipment to purge and sample that is compatible with the characteristics of the well and analytes being sampled. Operate equipment in accordance with the manufacturer instructions, unless otherwise specified in the project QAPP.
- 8.2.4 Properly collect, handle and store samples.
- 8.2.5 Collect the appropriate quality control samples. These may include a field replicate, and field blanks (e.g. filter, equipment, transport). The types and number of quality control samples should be specified in the project QAPP.
- 8.2.6 Follow the procedures in the project QAPP or Manchester Lab Manual for sample handling and management (e.g. chain of custody).
- 8.2.7 Document all data, observations, notes, deviations from project QAPP, etc. on the field data sheets and other project paperwork.
- 8.2.8 Properly clean, maintain, and store all field equipment after use.
- 8.2.9 Use consistent procedures from well to well.

## **9.0 Safety**

- 9.1 Proper safety precautions must be observed when collecting groundwater samples. Field work should follow protocols described in the Environmental Assessment Program Safety Manual (Ecology 2006). A working knowledge of sections 'Groundwater Sampling and Water-Level Measurements' and 'Hazardous Waste Sites' in Chapter 2 is expected. Protocols in the EAP Safety Manual should be used to complement the judgment of an experienced field professional.
- 9.2 A [Field Work Plan Form](#) must be completed to document field personnel, sampling locations, overnight lodging, planned itinerary, contact person(s), and emergency contacts. If using a boat to access a site an [Ecology Float Plan](#) must be completed.

- 9.3 Always consider the safety situations when sampling a monitoring well. In addition to the possible chemical hazards if the water to be sampled is contaminated, there are many physical hazards associated with sampling monitoring wells. Monitoring wells are frequently located on or near active business or industrial sites, so field staff must remain aware of the typical hazards associated with these sites such as traffic. Many wells are located in parking lots, alleyways, or along roadways. Consult the EAP Safety Manual for further guidance regarding working near traffic. Other physical hazards can include heavy lifting, noise, electricity, steep, slippery, or uneven terrain, animals or insects, and the weather.
- 9.4 All EA Program field staff who work on hazardous waste sites are required to complete and maintain certification in FIRST AID/CPR and the 40-hour Hazardous Materials Safety & Health Training.

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## **Appendix A: Example Field Forms**

EAP has developed several spreadsheet templates and field form to speed and where possible automate the tasks required to evaluate, install, and process groundwater sampling data. Examples of commonly used forms are included here. See EAP's Groundwater Assessment SharePoint site for up-to-date versions. These tools and forms can easily be modified to accommodate the needs of particular instruments or projects.

**Well Reconnaissance Field Sheet**

Date: \_\_\_\_\_ Time: \_\_\_\_\_

Field Crew: \_\_\_\_\_

Well ID: \_\_\_\_\_

Well Tag ID: \_\_\_\_\_

Well Owner Name: \_\_\_\_\_

Facility Name: \_\_\_\_\_

Current Phone Number: \_\_\_\_\_

Current Mailing Address: \_\_\_\_\_

Renter?  Name: \_\_\_\_\_

Permission granted to locate well?

Permission granted to collect Water Level?

Permission granted to sample well for Water Quality?

Permission granted to tag well?  Tagged?

Call ahead required before site visit?

Recon GPS Well Coordinates:

Recording Datum: NAD83HARN  NAD83  NAD27

DDLAT: \_\_\_\_\_ DDLONG \_\_\_\_\_

Wellhead Photo #: \_\_\_\_\_

Comments: \_\_\_\_\_

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**Add sketch map of well location on back**



Date	Time	Hold (ft)	Cut (ft)	Status	Mthd.	Accu.	Remark
/ /							
/ /							
/ /							
/ /							
/ /							
/ /							
/ /							
/ /							
/ /							
/ /							

Status Codes																
<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>N</b>	<b>O</b>	<b>P</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Z</b>
Dry	Recently Flowing	Flowing	Nearby Flowing	Nearby Recently Flowing	Injector	Site Monitor	Discon- tinued measuring	Obstruction	Pump- ing	Recently Pumped	Nearby Pumping	Nearby Recently Pumping	Foreign Matter on Water	Well Des- troyed	Affected by Surface Water Site	Other

  

Method of Measurement Codes													
<b>A</b>	<b>B</b>	<b>C</b>	<b>E</b>	<b>G</b>	<b>H</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>V</b>	<b>Z</b>
Airline	Analog	Cal. Airline	Estimate	Pressure Gage	Cal. Pressure Gage	Geophys Log	Mano- meter	Non- Recording Gage	Reported	Steel Tape	Electric Tape	Calibrated E-tape	Other

  

Measurement Accuracy Codes		
<b>0</b>	<b>1</b>	<b>2</b>
±1 FT	±0.1 FT	±0.01 FT

Well Name: \_\_\_\_\_

Well Tag ID: \_\_\_\_\_



**Groundwater Quality Sampling Field Sheet (cont.)**

Well Tag ID: \_\_\_\_\_ Well Name: \_\_\_\_\_

**Purge Parameters (cont.):**

Time	pH	Temp (°C)	Cond (µS/cm)	DO (mg/L)

Photometric O<sub>2</sub> :                      **Kit:** \_\_\_\_\_ **Conc.** \_\_\_\_\_

Photometric O<sub>2</sub> :                      **Kit:** \_\_\_\_\_ **Conc.** \_\_\_\_\_

Colormetric O<sub>2</sub> : \_\_\_\_\_

Field Alkalinity :                      **Kit:** \_\_\_\_\_ **Conc.** \_\_\_\_\_

ORP: \_\_\_\_\_

Other: \_\_\_\_\_

Comments :



# Sample Container Request Form

Please FAX to Leon Weiks: (360) 871-8850  
 (Phone for Leon Weiks: (360) 871-8825)

Requestor: \_\_\_\_\_

Project Name: \_\_\_\_\_

Phone: \_\_\_\_\_

Today's Date: \_\_\_\_\_

Location for Delivery: \_\_\_\_\_

Date Needed by: \_\_\_\_\_

Index #	Description	Qty.
1	1 gallon jar *	
2	1/2 gallon jar *	
3	1 liter jar * (wide mouth) (special request only)	
4	1 liter jar ( narrow mouth) (oil & grease) **	
5	8 oz short jar *	
6	8 oz short jar **	
8	4 oz short jar *	
9	4 oz short jar **	
11	40 mL vial w/septum *	
13	2 oz short jar w/septum * (Volatiles: solids only)	
14	125 mL amber glass bottle * (carbamate)	
15	1 liter amber bottle * (narrow mouth)	
16	500 mL HDPE bottle (metals)	
17	1 gallon cubitainer	
19	125 mL clear Nalgene (nutrients or COD; bottle contains 1:1 sulfuric acid)	
20	125 mL amber Nalgene (filters and syringe also required for orthophosphate)	
21	125 mL polypropylene bottle (hardness - bottle contains acid) <b>For Hexachrome, request bottle without acid</b>	

Index #	Description	Qty.
22	500 mL poly bottle	
23	1000 mL poly bottle	
24	1000 mL amber poly	
25	250 mL amber poly bottle (Cyanide) (contains Sodium Hydroxide)	
26	60 mL poly bottle (TOC/DOC or TP; bottle contains 1:1 hydrochloric acid)	
27	250 mL glass or poly bottle (fecal coli)	
28	500 mL glass bottle or poly (multiple micro tests)	
29	250 mL glass or poly bottle <b>with thiosulfate</b> (fecal coliform - chlorinated)	
30	500 mL glass or poly bottle <b>with thiosulfate</b> (multiple micro tests - chlorinated)	
31	8 oz plastic jar (grain size only)	
32	1 liter jar ** with <b>sulfuric acid</b> (wide mouth, clear; for phenolics)	
33	sterile specimen cup (micro)	
34	2 oz short jar (TOC - NO septum)**	
35	Soil VOA/BTEX Airtight Sampling Capsules (3 per sample)	
36	Soil VOA/BTEX Sampling Handle (1 per sampling event)	
	<b>Other Supplies</b>	

\*organic free with Teflon lined lids, with Certificate of Analysis. \*\*same as "\*" but does not include Certificate of Analysis.



# PRE-Sampling Notification

Fax to Manchester Laboratory: (360) 871-8850

**Project Name:** \_\_\_\_\_ **SIC:** \_\_\_\_\_  Enforcement  
**Requested by:** \_\_\_\_\_ **Sampling Date(s):** \_\_\_\_\_  Monitoring  
**Program:** \_\_\_\_\_ **Date to Lab:** \_\_\_\_\_  Emergency  
**Phone No.:** \_\_\_\_\_ **Sample Pickup Location:** \_\_\_\_\_  Class II  
**QAPP:**  Yes  No **Date results needed by:** \_\_\_\_\_  Preliminary Invest.  
 Special turnaround

General Chemistry	W	S	O	Microbiology	W	S	O	Organic Chemistry	W	S	O
Alkalinity				Fecal Coliforms <input type="checkbox"/> MF <input type="checkbox"/> MPN				Base/Neutral/Acids (BNA)			
Conductivity				E. Coli MF <input type="checkbox"/> "MUG" <input type="checkbox"/> mTEC2				Polynuclear Aromatics (PAH)			
Hardness				E. Coli MPN							
pH				% Klebsiella				Volatile Organic Analysis (VOA)			
Turbidity								BTEX			
<input type="checkbox"/> Fluoride <input type="checkbox"/> Chloride <input type="checkbox"/> Sulfate								Pest/PCB's (Organochlorine)			
Cyanide <input type="checkbox"/> Total <input type="checkbox"/> Dissociable				<b>Metals</b>	<b>W<sub>T</sub></b>	<b>W<sub>D</sub></b>	<b>S</b>	<b>O</b>	Pesticides only (Organochlorine)		
Total Solids				Priority Pollutant Metals (13 elements)				PCB's only			
Total Nonvolatile Solids				TCLP metals				OP - Pests (Organophosphorous)			
Total Suspended Solids				Hardness				Herbicides (Chlorophenoxy)			
Total Nonvolatile Suspended								Nitrogen Pesticides			
Total Dissolved Solids				Mercury (Hg) <input type="checkbox"/> Low Level <input type="checkbox"/> Regular				PCL Pesticides (8085)			
Chlorophyll <input type="checkbox"/> Filtered in field <input type="checkbox"/> Filtered at lab				Other: List individual elements:				PBDEs			
% Solids								Hydrocarbon ID (match to source)			
% Volatile Solids (TVS)								TPH-ID (gas/diesel/oil)			
Total Organic Carbon								TPH-G <sub>x</sub>			
Dissolved Organic Carbon								TPH-D <sub>x</sub>			
Biochemical Oxygen Demand (BOD) 5 day											
BOD - Inhibited								TCLP-VOA			
BOD - Ultimate								TCLP-BNA			
Ammonia								TCLP-Herbicides			
Nitrate-Nitrite								TCLP-Pesticides			
Orthophosphate											
Total Phosphorous											
<input type="checkbox"/> TPN <input type="checkbox"/> TKN				Asbestos							

Comments: Enter the number of samples in the appropriate box(es) above.  
 W = water S = soil/sediment O = other (please specify) W<sub>TR</sub> = water total W<sub>D</sub> = water dissolved



<b>Matrix Codes</b>	<b>Source Codes</b>	<b>Code Description</b>
<p><b>Code Description</b>  10 Water  11 Field Filtered Water  12 Filter from Water  13 Water to be filtered upon receipt at lab  40 Soil/Sediment  41 Frozen Soil/Sediment (PSEP)  45 Semi-Solid/Sludge  70 Tissue  80 Oil/Solvent  90 Waste  00 Other (Use only if no other apply)</p>	<p><b>Code Description</b>  00 Unspecified Source  01 Unknown Liquid Media (Drum/Tank)  02 Unknown Liquid Media (Spill Area)  03 Unknown Liquid Media (Waste Pond)  <b>10 Water (General)</b>  12 Ambient Stream/River  13 Lake Reservoir  14 Estuary/Ocean  15 Spring/Seepage  16 Rain  17 Surface Runoff/Pond (general)  18 Irrigation Canal/Return Flow  <b>20 Well (General)</b>  21 Well (Industrial/Agricultural)  22 Well (Drinking Water Supply)  23 Well (Test/Observation)  24 Drinking Water Intake  25 Drinking Water (At Tap)  <b>30 Effluent Wastewater (General)</b>  31 Municipal Effluent  32 Municipal Inplant Waters  33 Industrial Surface Runoff/Leachate  34 Industrial Effluent  35 Industrial Inplant Waters  36 Industrial Surface Runoff/Pond  37 Industrial Waste Pond  38 Landfill Runoff/Pond/Leachate  <b>40 Sediment (General)</b>  42 Bottom Sediment or Deposit  44 Sludge (General)  45 Sludge (WastePond)  46 Sludge (Drum/Tank)  48 Soil (General)  49 Soil (Spill/Contaminated Area)</p>	<p>50 Bore Hole Material  <b>60 Air (General)</b>  61 Ambient Air  62 Source or Effluent Air  63 Industrial or Workroom Air  <b>70 Tissue (General)</b>  71 Fish Tissue  72 Shellfish Tissue  73 Bird Tissue  74 Mammal Tissue  75 Macroinvertebrate  76 Algae  77 Periphyton  78 Plant/Vegetation  <b>80 Oil/Solvent (General)</b>  81 Oil (Transformer/Capacitor)  82 Oil/Solvent (Drum Tank)  83 Oil/Solvent (Spill Area)  84 Oil/Solvent (Waste/Pond)  <b>90 Commercial Product Formulation</b>  95 Well Drill Water  96 Well Drill Mud  97 Well Sealing Material  98 Gravel Pack Material</p>